Discussion Points

- Background

- Gasoline Monitoring Changes

- Other OBD II Changes

- Enforcement Regulation Changes

- Emission Warranty Regulation Changes

- Diesel Monitoring Changes

Diesel OBD Requirements

- Background
- Diesel Monitoring Requirements
  - Major Engine Monitors
  - Aftertreatment Monitors
  - Other Engine Monitors
  - Gasoline/Diesel Monitors
- Miscellaneous

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Methodology for Determining LDD/MDD OBD Requirements

- Monitoring requirements based on HD OBD

- Make diesel LD as clean and as stringently monitored as LD gasoline;

- Harmonize MDV with long-term phased-in HD emission thresholds.

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Methodology for Determining LDD/MDD OBD Req. (cont'd)

- More stringent threshold factor for engines dirtier than 0.5 NOx (e.g., 2.5 NOx+NMHC g/bhp-hr and 1.2 type engines),
  - 1.5 to 1.75x NOx standard
- Less stringent threshold factor for cleaner engines
  - 2.0 x NOx for 0.5 g/bhp-hr NOx or lower)

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Diesel Engine Major Monitors

- Fuel System

- Misfire

- EGR System

- Boost Pressure Control System

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Fuel System Monitoring

- 2004 + MY PCs, LDTs, and MDVs certified to a chassis dynamometer tailpipe emission standard
  - Detect following faults before emissions exceed 1.5 x standards for NMHC, CO, NOx, or PM:
    - fuel system pressure control
    - fuel injection quantity
    - fuel injection timing

- 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard > 0.50 g/bhp-hr NOx
  - Detect above faults before emissions exceed 1.5 x standards for NMHC, CO, or NOx; or PM > standard + 0.02 g/bhp-hr

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Fuel System Monitoring (cont'd)

- 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard $\leq$ 0.50 g/bhp-hr NOx

    – Detect above faults before emissions exceed 2.0 x standards for NMHC, CO, or NOx; or PM > standard + 0.02 g/bhp-hr

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Fuel System Monitoring (cont'd)

- Additional requirements for 2004+ MY Vehicles/ 2007+ MY Engines : Detect fault if closed loop system:

    – Fails to enter closed loop
    – Defaults out of closed loop
    – Control authority reaches limits

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Misfire Monitoring

- Requirement for 2004+ MY:
  - Must detect misfire occurring continuously in one or more cylinders during idle
- Requirement for 2010+ MY vehicles equipped with combustion/combustion quality sensors:
  - Monitor for misfire that causes NMHC, CO, or NOx emissions > 2.0 x standards; or PM emissions > applicable standard + 0.02 g/bhp-hr
  - Monitor during entire speed and load range

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Misfire Monitoring (cont'd)

- Full-range, intermittent misfire monitoring necessary
  - Aggressive use of EGR and other concepts such as HCCI cause engine to operate near combustion limits at various speeds and loads

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EGR System Monitoring

- 2004 + MY PCs, LDTs, and MDVs certified to a chassis dynamometer tailpipe emission standard
  - Detect following EGR faults before NMHC, CO, NOx, or PM emissions > 1.5 x standards

    - EGR Flow Rate
    - EGR Response Rate
    - EGR Cooling System Performance

- 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard > 0.50 g/bhp-hr NOx
  - Detect above faults before emissions exceed 1.5 x standards for NMHC, CO, or NOx; or PM > standard + 0.02 g/bhp-hr

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EGR System Monitoring

- 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard $\leq$ 0.50 g/bhp-hr NO

  – Detect above faults before emissions exceed 2.0 x standards for NMHC, CO, or NOx; or PM > standard + 0.02 g/bhp-hr

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EGR System Monitoring (cont'd)

- Additional requirement: Detect fault if closed loop EGR system:
  - Fails to enter closed loop
  - Defaults out of closed loop
  - Control authority reaches limits

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Boost Pressure Control Monitoring

- 2004 + MY PCs, LDTs, and MDVs certified to a chassis dynamometer tailpipe emission standard
  - Detect following faults before emissions exceed 1.5 x standards:
    - Under and over boost malfunctions
    - Slow response (VGT systems only)
    - Charge air undercooling
- 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard > 0.50 g/bhp-hr NOx
  - Detect above faults before emissions exceed 1.5 x standards for NMHC, CO, or NOx; or PM > standard + 0.02 g/bhp-hr

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Boost Pressure Control Monitoring

- 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard $\leq$ 0.50 g/bhp-hr NO

  – Detect above faults before emissions exceed 2.0 x standards for NMHC, CO, or NOx; or PM > standard + 0.02 g/bhp-hr

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Boost Pressure Control Monitoring

- Additional requirement: Detect fault if closed loop system:
  - Fails to enter closed loop
  - Defaults out of closed loop
  - Control authority reaches limits

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Diesel Engine Aftertreatment Monitors

- NMHC Catalyst

- NOx Catalyst (Lean NOx and SCR)

- NOx Adsorber

- PM Filter

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NMHC Catalyst Monitoring

- 2004 + MY PCs, LDTs, and MDVs certified to a chassis dynamometer tailpipe emission standard
  - Detect conversion efficiency fault before NMHC emissions exceed 1.75 x standards

- 2007+ MY MDVs certified to engine dynamometer tailpipe NMHC emission standard > 0.14 g/bhp-hr NMHC:
  - Detect conversion efficiency fault before NMHC emissions exceed 1.75 x standards

- 2007+ MY MDVs certified to engine dynamometer tailpipe NMHC emission standard $\leq$ 0.14 g/bhp-hr :
  - Detect conversion efficiency fault before NMHC emissions exceed 2.0 x standards

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NMHC Catalyst Monitoring (cont'd)

- For 2004 - 2009 MY vehicles, NMHC catalyst monitor may be exempted if the average FTP test NMHC conversion efficiency of the system < 30 percent

- Functional monitor to detect fault if:
    - Insufficient exotherm to achieve PM filter regen
    - Insufficient NO_2 feedgas generation for SCR
    - No NMHC conversion on clean-up/guard catalysts

NOx Catalyst Monitoring
(Lean NOx and SCR)

- 2004 + MY PCs, LDTs, and MDVs certified to a chassis dynamometer tailpipe emission standard:
  - Detect NOx conversion efficiency faults before NOx emissions > 1.75 x standards.

- 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard > 0.50 g/bhp-hr NOx :
  - Detect following faults before NOx emissions > 1.75 x standards:
    - NOx conversion efficiency
    - SCR reductant delivery

- 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard $\leq$ 0.50 g/bhp-hr NOx:
  - Same as above except detect faults before NOx emissions exceed the standards by 0.2 g/bhp-hr

NOx Catalyst Monitoring
(Lean NOx and SCR) (cont'd)

- Additional requirements for 2004+ MY Vehicles/ 2007+ MY Engines: Detect a fault if:

  – Separate reductant tank empty or filled with non-reductant
  – Feedback control of reductant:
    - Fails to enter closed loop
    - Defaults out of closed loop
    - Control authority at limits

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NOx Adsorber Monitoring

- 2004 + MY PCs, LDTs, and MDVs certified to a chassis dynamometer tailpipe emission standard
  - Detect NOx adsorber capability fault before NOx emissions exceed > 1.75 x applicable standards

- 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard > 0.50 g/bhp-hr NOx:
  - Detect NOx adsorber capability fault before NOx emissions exceed > 1.75 x applicable standards

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NOx Adsorber Monitoring (cont'd)

- 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard $\leq$ 0.50 g/bhp-hr NOx :

    - Same as above except detect faults before NOx emissions exceed the standards by 0.2 g/bhp-hr

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NOx Adsorber Monitoring (cont'd)

- Additional requirements for 2004+ MY Vehicles/ 2007+ MY Engines: Detect a fault if:

    - Insufficient active/intrusive injection to achieve desorption of NOx adsorber
    - Feedback control of NOx adsorber or active/intrusive injection system:
        - Fails to enter closed loop
        - Defaults out of closed loop
        - Control authority reaches limits

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PM Filter Monitoring

- 2004+ MY PCs, LDTs, and MDVs certified to a chassis dynamometer tailpipe emission standard
  - Require following faults to be detected before emissions exceed 1.5 x applicable FTP standards:
    - Filtering Performance (PM)
    - Frequent Regeneration (NMHC)
    - Catalyzed Filters – NMHC Conversion Capability (NMHC)

- 2007-2009 MY MDVs certified to an engine dynamometer tailpipe emission standard; NMHC emission standard > 0.14 g/bhp-hr NMHC :
  - Require PM fault to be detected before PM emissions exceed 0.05 g/bhp-hr or the applicable standard plus 0.04 g/bhp-hr
  - Detect NMHC faults before NMHC emissions exceed 1.75 x standards

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PM Filter Monitoring (cont'd)

- 2010+ MY MDVs certified to an engine dynamometer tailpipe emission standard; NMHC emission standard $\leq$ 0.14 g/bhp-hr:

  – Same as above except detect PM fault before PM emissions exceed 0.003 g/bhp-hr or the applicable standard plus 0.02 g/bhp-hr

  – Detect conversion efficiency fault before NMHC emissions exceed 2.0 x standards

PM Filter Monitoring (cont'd)

- Additional requirements for 2004+ MY Vehicles/ 2007+ MY Engines :
  - Functional monitor for:
    - Incomplete regeneration
    - Missing substrate
    - Insufficient injection for active PM filter regeneration
  - Detect a closed loop regeneration system fault:
    - Fails to enter closed loop
    - Defaults out of closed loop
    - Control authority reaches limits

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Diesel Engine Additional Monitors

- Exhaust Gas Sensors
- VVT System

Exhaust Gas Sensor Monitoring

- Upstream A/F sensors

  – 2004+ MY PCs, LDTs, and MDVs certified to a chassis dynamometer tailpipe emission standard
    - Detect fault before any emissions exceed 1.5 x standards

  – 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard > 0.50 g/bhp-hr NOx
    - Detect fault before emissions exceed 1.5 x standards for NMHC, CO, or NOx; or PM > standard + 0.02 g/bhp-hr

Exhaust Gas Sensor Monitoring

- Downstream A/F sensors:
  - 2004+ MY PCs, LDTs, and MDVs certified to a chassis dynamometer tailpipe emission standard
    - Detect fault before any emissions exceed 1.5 x standards
  - 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard > 0.50 g/bhp-hr NOx
    - Detect fault before emissions exceed
      - x 2.0 x standard for NMHC
      - x 1.5 x standard for CO
      - x 1.75 x standard for NOx
      - x or 0.05 g/bhp-hr PM, or applicable PM standard + 0.04 g/bhp-hr
    - If certified to NMHC emission standard > 0.14 g/bhp-hr
      - x 1.75 x standard for NMHC

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Exhaust Gas Sensor Monitoring (cont'd)

- Downstream A/F sensors:

  - 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard $\leq$ 0.50 g/bhp-hr NOx

    - Detect fault before emissions exceed
      - x 2.0 x standard for NMHC
      - x 1.5 x standard for CO
      - x Applicable NOx standards + 0.2 g/bhp-hr NOx
      - x or 0.03 g/bhp-hr PM, or applicable PM standard + 0.02 g/bhp-hr For downstream sensors in 2010-2012:

Exhaust Gas Sensor Monitoring (cont'd)

- NOx sensors:
  - 2004+ MY PCs, LDTs, and MDVs certified to a chassis dynamometer tailpipe emission standard
    - Detect fault before any emissions exceed 1.5 x standards
  - 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard > 0.50 g/bhp-hr NOx
    - Detect fault before emissions exceed 1.75 x standards for NOx;
    - or PM > standard + 0.04 g/bhp-hr

Exhaust Gas Sensor Monitoring (cont'd)

- NOx sensors:

    – 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard $\leq$ 0.50 g/bhp-hr NOx

        - Detect fault before emissions exceed applicable NOx standards + 0.2 g/bhp-hr;
        - or PM > 0.03 g/bhp-hr, or PM standard + 0.02 g/bhp-hr

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Exhaust Gas Sensor Monitoring (cont'd)

- Additional requirements for 2004+ MY chassis/2007+ MY engine: Detect the following faults for all sensors:

  - Circuit/out-of-range faults
  - Feedback faults that cause an emission control system to default out of closed loop
  - Insufficient performance of the sensor for use for other OBD monitors
  - Heater performance and circuit faults

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VVT System Monitoring

- 2004 + MY PCs, LDTs, and MDVs certified to a chassis dynamometer tailpipe emission standard
  - Detect following faults before emissions exceed 1.5 x standards:
    - target error
    - slow response

- 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard > 0.50 g/bhp-hr NOx
  - Detect above faults before emissions exceed 1.5 x standards

- 2007+ MY MDVs certified to an engine dynamometer tailpipe NOx emission standard $\leq$ 0.50 g/bhp-hr NO
  - Detect above faults before emissions exceed 2.0 x standards

Cooling System Monitoring

- Requirement: Monitor cooling system (e.g., thermostat, ECT sensor) for proper performance:
    - must reach minimum temperature necessary to enable other OBD monitors or any emission control strategy within a reasonable time
    - must reach near thermostat-regulating temperature within a reasonable time

PCV System Monitoring

- Detect disconnection of the system between:
  - the crankcase and PCV valve, or
  - the PCV valve and the intake manifold.
  - Or, design the systems to avoid disconnection

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Comprehensive Component Monitoring

- Required to monitor electronic components that are used/inputs to the engine controller and that:
  - can cause a measurable emissions increase during any reasonable driving condition, OR
  - affect any other OBD monitors
- Requirement: Detect following faults:
  - circuit and rationality faults for input components
  - functional faults for output components
- Monitors not tied to emission thresholds

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Other Emission Control System Monitoring

- Required to monitor other emission control systems that are:
  - not identified under the other monitoring sections, OR
  - identified as a comprehensive component, but not corrected or compensated for by an adaptive control system

- Manufacturers required to submit a plan detailing monitoring strategy and malfunction criteria for ARB approval

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Miscellaneous

- Fuel System Component Tolerance Coding
  - Some manufacturers utilize coding of fuel injectors/fuel pumps to adjust for flow characteristic differences
  - Staff is concerned that an engine operating with the wrong coding for coded parts could have increased emissions without an indication of a malfunction to the vehicle operator
  - How do we address this issue?

Miscellaneous – standardization changes

- Updated standardization specifications: J1939-73, more diesel-specific engine parameters to be supported, etc.
  - Fuel inj. timing, intake man. temp., intercooler temp., etc.
  - 2010 MY+ eng.-dynamometer-certified MDVs
    - NOx NTE real-time control area status, PM NTE real-time control area status

Miscellaneous – In-use Performance/Tracking changes

- Track and report in-use performance:
  - Various Catalyst monitors
  - Exhaust Gas Sensors
  - EGR system
  - PM filter
  - NOx adsorber
- 0.336 minimum ratio
- No interim ratios

Miscellaneous- AECD Tracking

- For diesels, require real-time tracking and cumulative logged data:
  - Engine run time with each individual emission increasing AECD active
- Valuable tool for emission testing (verify collected data were valid)
- Can can be used by certification staff for future model year approvals of AECDs
- Assist in evaluating OBD monitoring frequencies during certification

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What is an emission-increasing AECD?

- Any approved AECD that is not classified as an NTE deficiency but causes emissions to exceed the NTE emission limits regardless of whether it occurs within or outside of the NTE control area.
    - Extended idle strategy or other engine protection strategies that cause emissions to exceed the numerical NTE emission limits even though they may not occur inside the NTE control area